

D0 Responses to the Recommendations of the December, 2001 Run 2b Technical Review Committee

March 28, 2002

1. **Recommendation, Section II.A.3:** A very aggressive acquisition strategy is recommended, which includes the identification of cost drivers in the sensor specs, including the possibility of using thicker detectors. In addition, the sensor purchase should be coordinated between the two experiments, to obtain the lowest unit cost.

Response: D0 has been poised to pursue aggressive strategies for all procurements, including the sensors. While we understand the potential savings associated with pursuing thicker detectors, the impact to the mechanical design would be substantial, and hence would in all likelihood result in a schedule delay that we feel Run 2b is not prepared to absorb. Our estimates are that a definitive reconsideration of the mechanical design would take of order six months, while simultaneously diverting progress on the baseline design. Moreover, in light of the exceedingly tight spatial constraints, realizing a successful design based on this technology is in no way guaranteed. These reasons, coupled with the stringent schedule constraints associated with Run 2b, lead us to believe that the serious pursuit of this option would be undesirable at this time. In an effort to inform ourselves as to the issues associated with purchasing these sensors, however, we have contacted two vendors about the possible production of thicker devices. Discussions with them are ongoing.

2. **Recommendation, Section II.A.4:** We encourage the experiments to explore tightening the tolerance on the sensor dicing, so that sensor edges can be used for mechanical alignment of the sensors on the ladder. This would lead to faster assembly and reduced manpower requirements.

Response: We feel that the potential loss in accuracy associated with using sensor edges rather than fiducials for alignment would impact the schedule as well as the final detector performance. It was suggested we contact BaBar to discuss this technique; we did this and were told that they, like us, were using fiducials. We did not contact any other experiments. The CMMs at SiDet will be available for use in aligning the sensors by their fiducials and, although a bit more manpower might be required, we feel that our proven success and experience using this technique sufficiently motivates our retaining this in our baseline fabrication plan.

3. **Recommendation, Section II.A.5:** In laying out their detectors both groups have made a commendable effort to simplify their design and to keep the number of different parts (HDIs, sensors, cables etc.) to a minimum. Further reduction might be possible at the cost of some performance reduction. For instance, the outer layer stave design might be used in the Layer 1 layout.

Response: While we consider it unlikely that any further simplification will result in any time- or cost-effective savings of significance, we nonetheless are continuing to look into such possibilities. Constraints for each of the layers demand that the outer and Layer 1 staves differ in several significant respects. For example, the width of Layer 2-5 staves is inconsistent with a hermetic design that fits the space available for Layer 1. In addition, incidence angles for tracks near sensor edges would require tightening constraints on radial position and sensor flatness beyond those we expect to achieve for Layer 2-5 staves. The change in the design of either layer to accommodate a single staff would require a reconsideration of the detector specifications that we feel would potentially compromise the detector performance. We feel such studies are unlikely to yield sufficient gains and thus do not warrant such an investigation, particularly in light of the project cost in both time and manpower.

4. **Recommendation, Section II.A.7:** The committee encourages the CDF and D0 groups to investigate other potential areas of common development such as hybrids and staves. This could allow savings on budget, schedule, and risk. In particular the groups should consider using the same Layer 0 design.

Response: We feel that all possibilities for exploiting commonality between the two experiments have been pursued as far as possible and/or sensible. Information nevertheless continues to be actively shared between the two experiments. The hybrids use the same technology. Differences in cables, axial vs. stereo readout, and other intrinsic detector features dictate that the staves be approached somewhat independently by the two experiments. The baseline Layer 0 conceptual designs for both experiments are identical; by necessity, the technical designs diverge in order to conform to the different constraints in the two experiments.

5. **Recommendation, Section II.A.8:** The analog flex cables used in Layer 0 are a source of concern, both in terms of possible noise increase and digital signal pickup, and in terms of production risks. The groups should use an established technology, a conservative layout, and contemplate multiple vendors. A collaboration of the two experiments on the acquisition would reduce the risks involved.

Response: We know of no “established technology” for these cables, but this only serves to underscore the concern here, which we share with the Committee. All of these points are being addressed.

6. **Recommendation, Section II.A.9:** We recommend that full QC/QA procedures are specified for all parts and that testing is limited to the crucial steps in the assembly.

Response: We are pursuing such a plan.

7. **Recommendation, Section II.A.10:** We recommend using tight specifications on the overall leakage current, and eliminating time consuming tests of single strip currents. Similarly, the coupling capacitor, I-V and C-V curves of the sensors should be tested by the manufacturer and only spot-checked by the experiments. The total current should be measured before every integration step and coupling caps should be tested after bonding. This limitation of the testing to a few vital parameters will free up personnel for other tasks.

Response: The tight specifications are being pursued, as are testing by the manufacturer of the I-V and C-V curves. In our experience, the total current has in the past shown anomalies that make it questionable for use as a diagnostic benchmark, but we will investigate this further for the Run 2b detectors.

8. **Recommendation, Section II.A.11:** The impact of radiation damage on resolution should be investigated with irradiated sensors. This might be done as a joint project between the two experiments.

Response: We continue to investigate the effects of radiation damage on our sensors. We have been, and continue to be, receptive to joint investigation of these effects between the two experiments.

9. **Recommendation, Section II.A.3 (Budget, Schedule, & Manpower):** We recommend that both experiments include in their schedules a full sector test of the final detector. This would allow an early detection of noise and other problems associated with system integration.

Response: This is being planned.

10. **Recommendation, Section II.A.4 (Budget, Schedule, & Manpower):** The committee recommends that the two groups reevaluate their manpower needs according to clear rules to be provided by the laboratory management, starting from the detailed schedule and clearly separating out baseline needs from contingency. The manpower estimate should properly detail as a function of time all work done inside and outside the laboratory, whether or not it is charged to the project.

Response: This is being done.

11. **Recommendation, Section II.A.2 (Descoping Options):** The present design can be descoped in various ways such as by removing layers, reducing acceptance, or reducing segmentation. We recommend the groups study the relative performance of the various options, in the metric of the Higgs search, before baselining the project.

Response: See recommendation 15 below.

- 12. Recommendation, Section II.C.3 (Budget, Schedule, and Manpower):** The M&S budget appears to be sound. In the discussion, several items were identified for which lower cost estimates or bids have been received, or for which expectations of cost savings have been advanced. These point to potential savings of \$1-2M. D0 management refused the temptation to reduce the budget now in order to meet the laboratory guidelines. In the future these savings should be included in the estimates, using appropriate contingencies.

Response: Our cost estimate is being prepared with a full Basis for Estimate, including contingency.

- 13. Recommendation, Section II.C.3 (Budget, Schedule, and Manpower):** The committee feels a set of order 10 higher level milestones should complement the detailed milestones.

Response: This has been done.

- 14. Recommendation, Section II.C.7 (Budget, Schedule, and Manpower):** It is recommended that they [D0] identify clearly the tasks related to the critical path (e.g. SVX4 test and preparation, module test and preparation) and make sure sufficient resources are allocated, taking into account some delays in competing tasks. On the other hand, the group is very experienced and should be able to “hit the ground running.” Simplification of assembly and test procedures might help.

Response: This is continually being done.

- 15. Recommendation, Section II.C.1 (Descoping Options):** The committee examined some descoping options that might be exercised if needed:

1. Smaller detector. The present design can be descoped in various ways:
 - Leave out Layer 4, Layer 1, or both
 - Leave off sensors at high z
 - More ganging
- i) We recommend that the group study the relative performance of the various options, in the metric of the Higgs search.

Response: Much of this was either presented or in process at the review. Remaining studies are being completed. A document describing these studies and our conclusions will be prepared in time for distribution and discussion at the April 12-13, 2002 PAC meeting.

16. Recommendation, end Section IV: The proponents should refine the funding profile for the trigger/DAQ projects in order to better fit the profile of available resources. It appears that many of the procurement costs can be back-end loaded, although development funds will be needed for all items at a fairly early stage.

Response: There is no way to further back-end-load the funding of the trigger projects without potentially compromising the ability to acquire luminosity in a timely way as Run 2b begins. The trigger projects are as essential to the D0 Run 2b physics program as is the silicon, and will require a suitable amount of schedule contingency to guarantee success. Back-end-loading these costs requires using much of this contingency up front, which we do not under the circumstances feel is desirable. As was done in Run 2a, we intend to pursue forward funding from our university collaborators to help relieve deficits in the financial profile for Run 2b.